

CLAIMS

What is claimed is:

1. A system for balancing state of charge among plural series connected electrical energy storage units, comprising:
5 a string of electrical energy storage units; and
 a power converter selectively coupled to an individual storage unit of the string, the power converter transferring energy bidirectionally between the individual storage unit and the string of storage units.
2. The system of claim 1 wherein the power converter transfers energy at a
10 controllable rate of transfer.
3. The system of claim 1, wherein the power converter monitors voltage and current data of the individual storage unit resulting from the transferring of energy.
4. The system of claim 1, wherein the power converter transfers units of energy
15 between the individual storage unit and the string of storage units.
5. The system of claim 1, wherein the power converter comprises:
 a primary inductor;
 a first secondary inductor magnetically coupled to the primary inductor;
20 a first switch selectively coupling the individual storage unit to the primary inductor; and
 the first secondary inductor coupling to an output capacitor;

the output capacitor coupled in parallel to the string of storage units.

6. The system of claim 5, wherein:

5 when the first switch is on, energy is transferred from the individual storage unit to charge the primary inductor; and
when the first switch is off, the energy being discharged into the first secondary inductor to charge the output capacitor, the output capacitor discharging energy to the string of storage units.

7. The system of claim 5, further comprising:

10 a first pulse generator providing first enable signals to the first switch;
the first switch coupling the individual storage unit to the primary inductor in response to the first enable signals, resulting in energy being transferred from the individual storage unit to the string of storage units.

- 15 8. The system of claim 7, further comprising:

a second pulse generator providing second enable signals to the first pulse generator;
the first pulse generator providing first enable signals in response to the second enable signals, the second enable signals controlling a
20 transfer of energy from the individual storage unit to the string of storage units at a controllable rate.

9. The system of claim 8, further comprising:

a second secondary inductor coupled to the individual storage unit, the second secondary inductor having a secondary voltage;
25 a voltage comparator;

a reference voltage and the secondary voltage being inputs of the voltage comparator.

10. The system of claim 9, wherein the second pulse generator is activated when the secondary voltage is greater than the reference voltage.
- 5 11. The system of claim 9, wherein the second pulse generator is deactivated when the secondary voltage reaches the reference voltage.
12. The system of claim 1, further comprising:
- a primary inductor;
- a first secondary inductor magnetically coupled to the primary
- 10 inductor;
- a second switch selectively coupling the first secondary inductor to the string of storage units;
- energy being transferred from the string of storage units to charge the first secondary inductor when the second switch is on;
- 15 the energy being discharged into the primary inductor and charging the individual storage unit when the second switch is off.
13. The system of claim 12, further comprising:
- a first pulse generator providing first enable signals to the second switch;
- 20 the second switch coupling the string of storage units to the first secondary inductor in response to the first enable signals, resulting in energy being transferred from the string of storage units to the individual storage unit.

14. The system of claim 13, further comprising:
a second pulse generator providing second enable signals to the first pulse generator;
the first pulse generator providing first enable signals in response to the second enable signals, the second enable signals controlling a transfer of energy from the string of storage units to the individual storage unit at a controllable rate.
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15. The system of claim 14, further comprising:
a second secondary inductor coupled to the individual storage unit, the second secondary inductor having a secondary voltage;
a voltage comparator;
a reference voltage and the secondary voltage being inputs of the voltage comparator.
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16. The system of claim 15, wherein the second pulse generator is activated when the secondary voltage is less than the reference voltage.
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17. The system of claim 15, wherein the second pulse generator is deactivated when the secondary voltage reaches the reference voltage.
18. The system of claim 1, wherein the power converter comprises:
an up-converter transferring energy from the individual storage unit to the string of storage units; and
a down-converter transferring energy from the string of storage units to the individual storage unit.
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19. The system of claim 18, wherein the power converter comprises:

a common transformer that is used as a down converter to transfer energy from the string of storage units to charge the individual storage unit; and

5 the common transformer that is used as an up converter to transfer energy from the individual storage unit to the string of units in order to discharge the individual storage unit.

20. The system of claim 1, wherein each storage unit is a storage cell.
21. The system of claim 1, wherein each storage unit is a battery module having a string of storage units.
- 10 22. The system of claim 1, wherein a battery pack comprises a string of one or more storage units.